"The Effectiveness of Risk Management Within the DoD"

Funded by the Naval Postgraduate School, Dr. Keith Snider

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Presented at the 9th Annual Acquisition Research Symposium,
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BLUF

1. Uncertainty first, risk second

2. Based on GAO reports, some things aren't reducing risk

   • TRL's, Design Maturity, EVM

3. Software development and integration are being ignored

4. DoD Workforce are big risk takers even when they shouldn't be

5. Workforce needs risk management training that focuses on doing it effectively (Proficiency)

   • Not learning about likelihood, consequence, mitigation methods, software tools, etc.

6. If you're not successful at mitigating risks, don't do it.

> "I have never let my schooling interfere with my education."
> - Mark Twain

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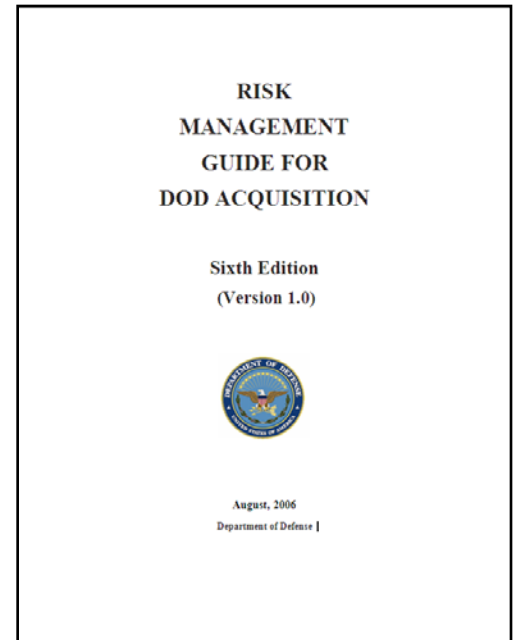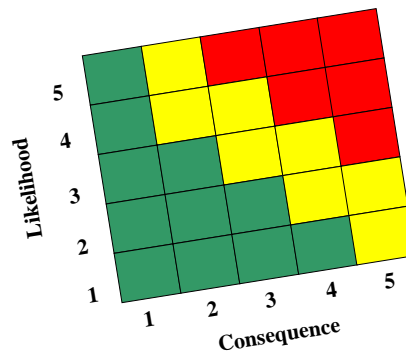
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Topics

1. Facts concerning major weapon programs

2. Survey of the DoD workforce on risk management

3. Risk behavior of the DoD workforce

4. Monte Carlo modeling of risk

5. Interviews with DoD and Industry Program Managers

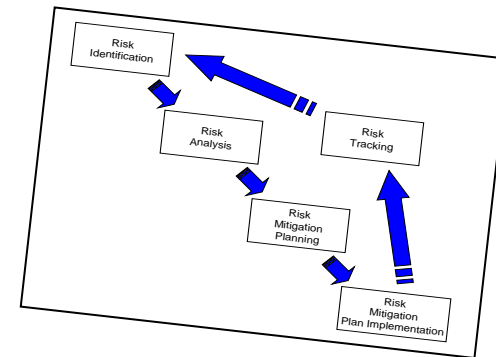"If we don't succeed, we run the risk of failure." – J. Danforth Quayle

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What I'm Not Going to Talk About

- ➢ What is Risk?
- ➢ The DOD Risk Management Guidebook
- ➢ Risk Mitigation
- ➢ DAU

RISK MANAGEMENT GUIDE FOR DOD ACQUISITION

Sixth Edition (Version 1.0)

August, 2006
Department of Defense

Risks have three components:
- A future root cause (yet to happen), which, if eliminated or corrected, would prevent a potential consequence from occurring,
- A likelihood (or probability) assessed at the present time of that future root cause occurring, and
- The consequence (or effect) of that future occurrence.

- **Avoid**
- **Control**
- **Transfer**
- **Accept**

Risk Identification — Risk Analysis — Risk Tracking — Risk Mitigation Planning — Risk Mitigation Plan Implementation

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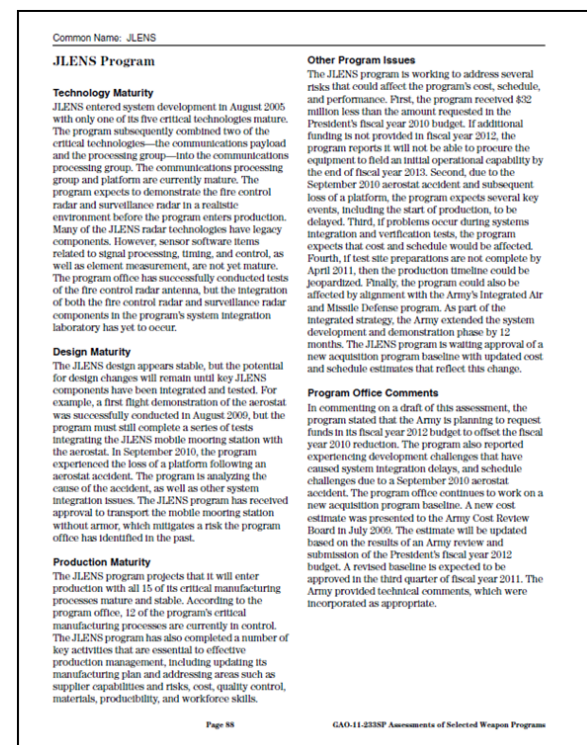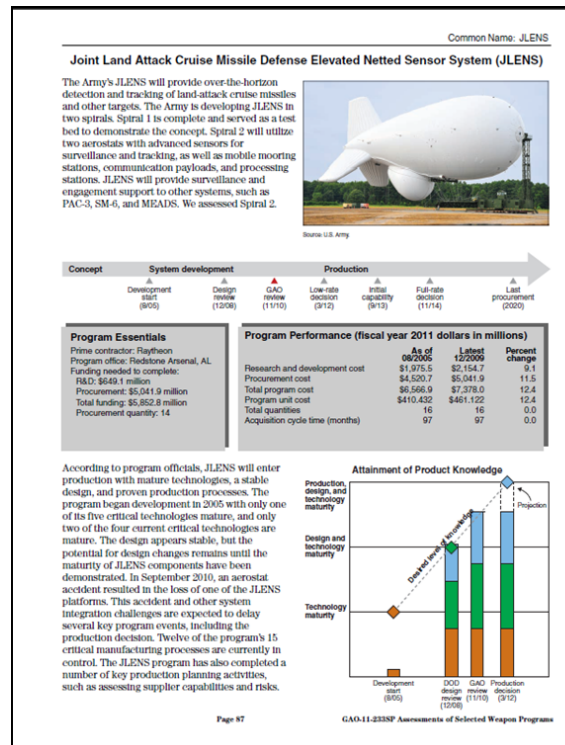May 16-17, 2012 in Monterey, CA.

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Topics

1. **Facts concerning major weapon programs**
   - technology maturity (TRL), design maturity, software maturity, earned value management (EVM)

2. Survey of the DoD Workforce on risk management
   - feedback on how RM is used on programs
   - recommendations from survey participants

3. Risk behavior of the DoD workforce
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   - Impact on program cost and schedule

5. Best practices, lessons learned and new approaches to risk management from DoD and Industry Program Managers

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Let's look backward to prepare for the future

➢ 9 years of GAO reports

➢ e.g. "Defense Acquisitions: Assessments of Major Weapon Programs", GAO-03-476 (May 2003)

➢ Example report
2 pages per yr.

"You can observe a lot by just watching." – Yogi Berra

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Disclaimer About Data in the GAO Reports

➢ Non-attribution (please).

➢ The data in the write-ups were used as is and there wasn't an attempt to fix any apparent discrepancies.

➢ The impact of changes in the program scope were hard to identify.

➢ Costs were adjusted for inflation.

➢ Hard to compare one program to another.

"Errors using inadequate data are much less than those using no data at all."
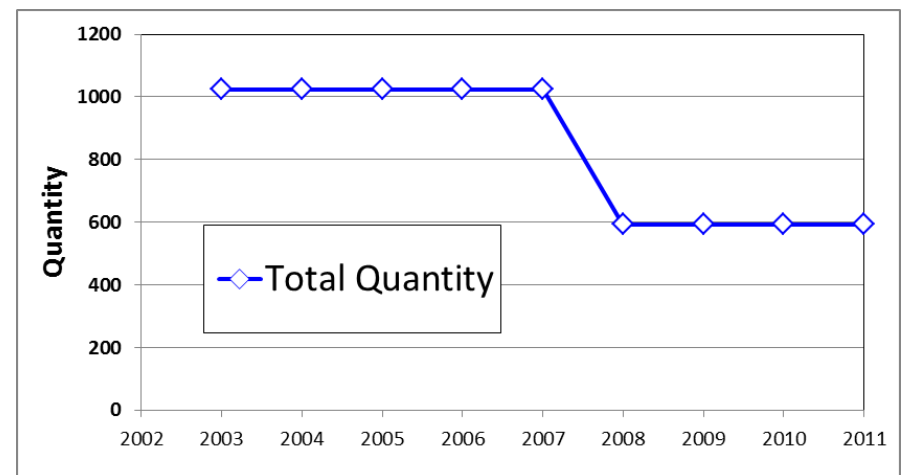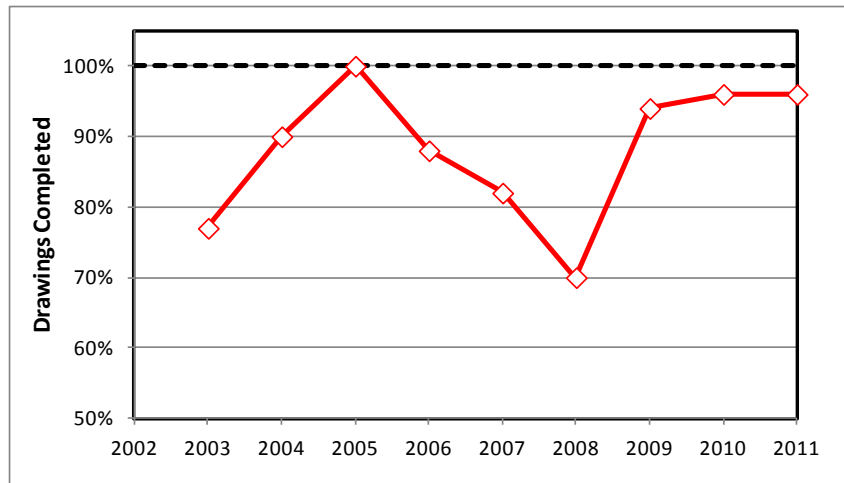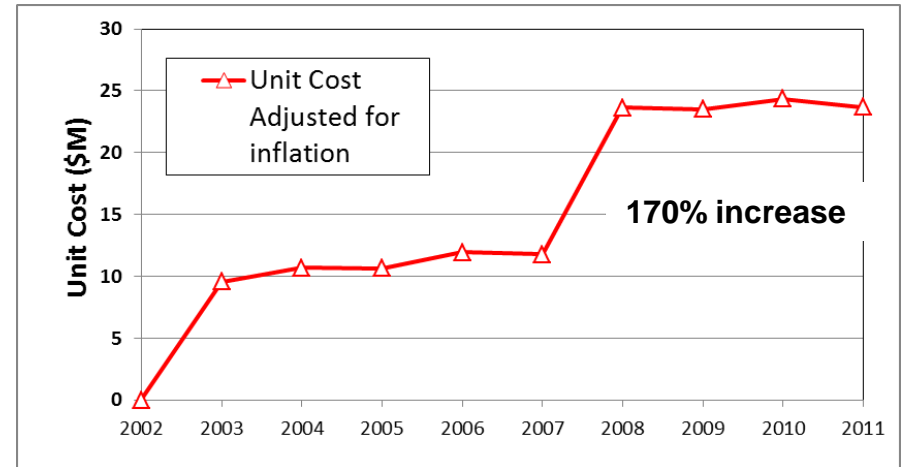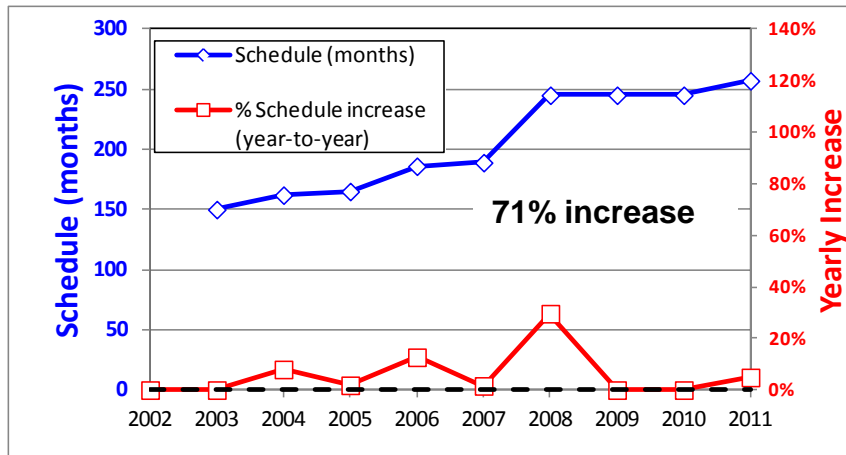- Charles Babbage

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Technology, Design & Production Maturity – Program B

Year	Program Unit-Cost Growth*	Schedule Delay	Technology	Design	Drawings Completed
2003	9%	0%	4 of 5 mature	Stable	77%
2004	22%	8%	Remaining tech. has not matured	Changes … to mostly attain better mfg'ing efficiencies…	67%
2005	21%	10%	All mature	Released.	All released but 12% to be changed.
2006	36%	24%	All mature	Released	All released but 12% to be changed.
2007	34%	26%	All mature	Production decision delayed	82%
2008	169%	63%	All Mature	Redesigning	70%
2009	168%	63%	All Mature	Stable	94%
2010	178%	63%	All Mature	Design "will continue to evolve"	96%
2011	170%	71%	All Mature	"Still evolving"	-

- Mature technology.
- Design never stabilized.
- % Drawings completed dropped from 100% to 70%

- 170% Unit Cost Growth from 2003 to 2011
- 71% Schedule Delay

*Adjusted for inflation.

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Some Risk Management Tools

- ➢ Technology Readiness Levels (TRL)
  - Measure of risk in technology development during EMD.

- ➢ Design Drawings
  - How the design is maturing during EMD.

- ➢ Software Maturity

- ➢ Earned Value Management (EVM)
  - Used to forecast cost over-runs and schedule delays & to enable better management of the program

EMD = Engineering and Manufacturing Development, DODI 5000.02

"The bigger the real-life problems, the greater the tendency for the discipline to retreat into a reassuring fantasy-land of abstract theory and technical manipulation." - Tom Naylor

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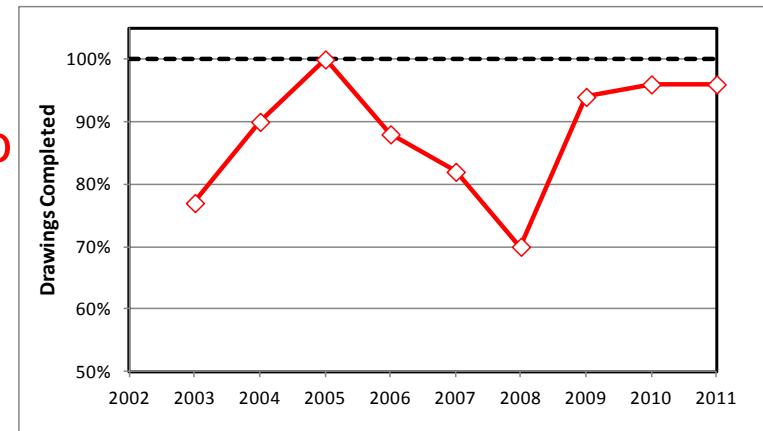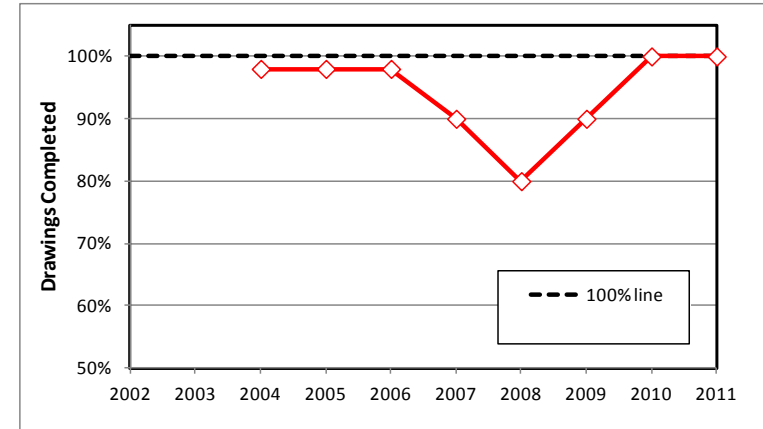
Technology Readiness Levels (TRL)

- ➢ R&D Cost Growth* after reaching full maturity:
  - • 75% over 8 years
  - • 65% over 6 years
  - • 16% over 7 years
  - • 6.5% over 4 years
  - • 120% over 3 years
  - • 2 programs never reached full maturity; 1 program not counted

- ➢ Technology maturity was not a good indicator of successful engineering and manufacturing development.

- ➢ Technical maturity does not guarantee cost or schedule performance.

- ➢ Overall, TRL's are not as useful as we claim they are. They give us an overly optimistic assessment of program risk.

* Adjusted for inflation

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Of 8 programs…

- ➤ 4 had significant drops in "releasable" drawings
  - 100% to 70%, 98% to 80%, 98% to 90%, 100% to 82%
- ➤ 1 had a 10% drop after 5 years at 100%
- ➤ 2 had continuous design development
- ➤ 1 did not have useful data
- ➤ Lesson learned – not an accurate way to measure the maturity of the design.
- ➤ Quoted values are very suspect.
- ➤ BUT, it's a leading indicator of future problems! (About 1 year)

"Prediction is very difficult, especially about the future." - Niels Bohr

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➢ ~37% of the program write-ups did not include software at all.

➢ Interesting quotes from the GAO reports
  • "Developing the complex flight software subsystem … has already <u>caused multiple delays</u>, and DCMA has reported that the remaining software effort <u>will likely further delay</u> the launch …"

  • ".. the greatest risk … is software development and integration…"

➢ Lesson learned – The focus of the write-ups tends to be "hardware" focused and the risk of software development and integration is often ignored. We have little insight into a major area of program risk.

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- ➢ For 8 programs over 9 years, Earned Value was only mentioned twice:

  - *"The program office has had reduced insight into its prime contractor's work progress since December 2004 because it <u>has not received detailed earned value cost and schedule data</u>."*

  - *"The Defense Contract Audit Agency has identified <u>significant deficiencies</u> with the prime contractors' earned value management system that affects the Air Force's ability to oversee the cost aspects of the program."*

- ➢ Lesson learned – If EVM is being used on the 8 programs studied, it was not identified in the yearly write-ups. There is no indication that program execution is being influenced by EVM data.
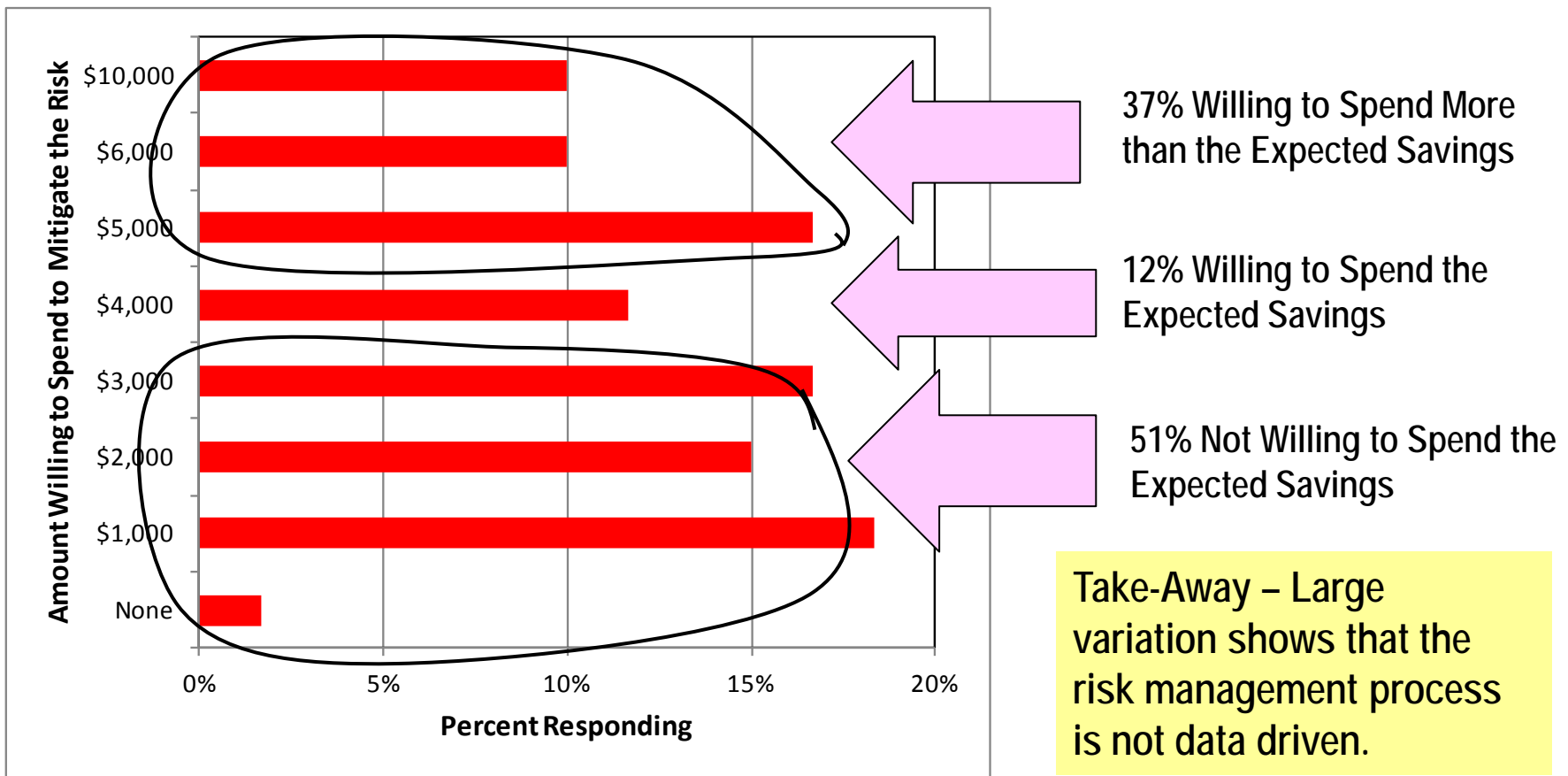
"Experience is that marvelous thing that enables you to recognize a mistake when you make it again."
- F. P. Jones

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> ➢ "In your opinion, how important are the following activities for successful risk management?"

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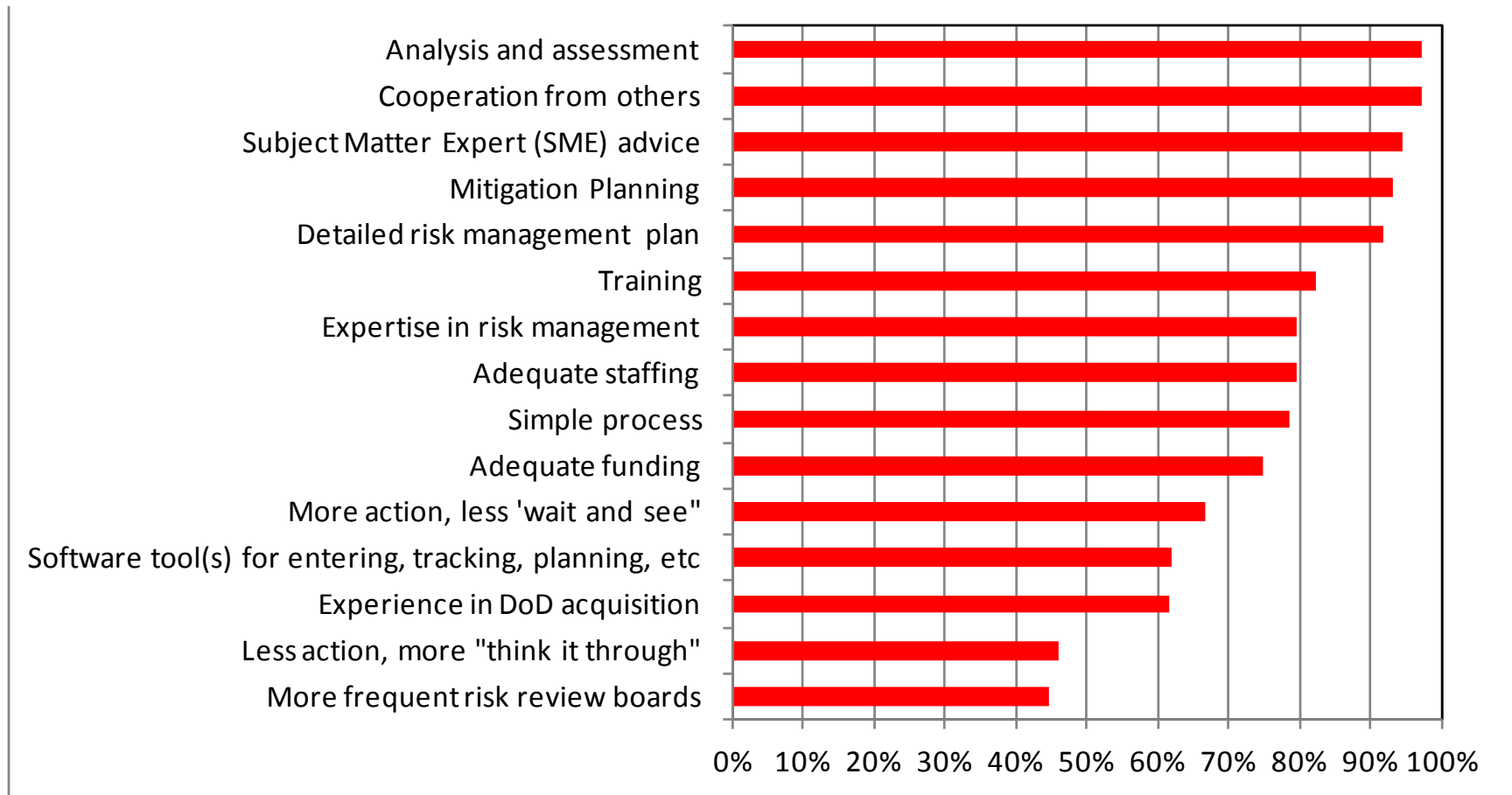
➢ Theme #1

- analysis and assessment (97%)
- SME advice (95%)
- mitigation planning (93%)
- training (82%)
- expertise in risk management (79%)

➢ This is doing risk management, not learning about likelihood, consequence, the risk matrix, the DoD Risk Management Guidebook, etc.

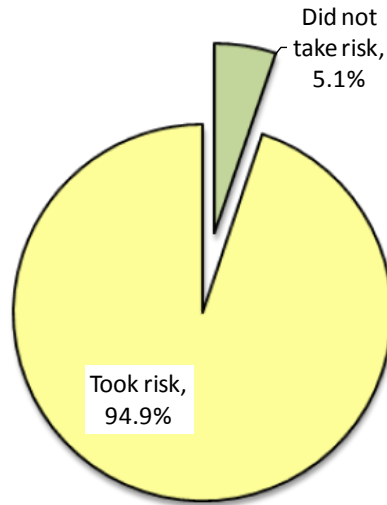➢ Proficiency of doing risk management and mitigation.

"If you think education is expensive, try ignorance."
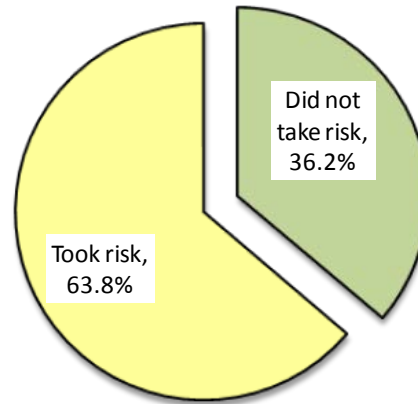- Derek Bok

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"I didn't think; I experimented." - Wilhelm Roentgen

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Results of Risk Experiment #2- Rewards From Risk Taking

Did not take risk, 5.1%

Took risk, 94.9%

- **Program is Over Budget**
- **95% Took Risk**

Did not take risk, 36.2%

Took risk, 63.8%

- **Program is On Budget**
- **64% Took Risk**

Did not take risk, 11.0%
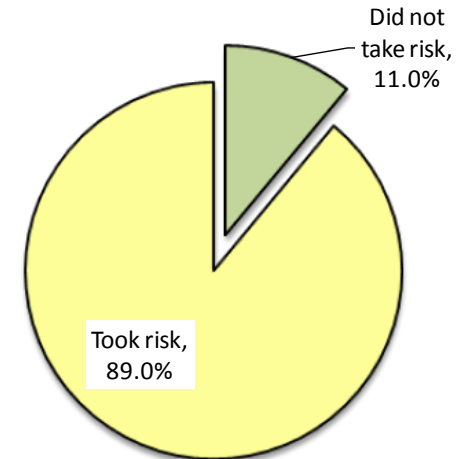
Took risk, 89.0%

- **Program is Under Budget**
- **89% Took Risk**

Risk experiment. 98 students (3 classes).

All students started on budget. Simulated 5 months.

Students could select the budgeted monthly amount, or could take risk.

No risk = $10. If they took risk, 50% Chance $8 & 50% chance of $14

Students on or under budget could select a small prize (lowest chooses first)

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"The great tragedy of Science - the slaying of a beautiful hypothesis by an ugly fact."
- Thomas Henry Huxley

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Clarification of "Risk"

➤ Don's consideration for this briefing

➤ Uncertainty in Effort
  - the task is required and will be completed in the future
  - there is some uncertainty in the cost and time to complete (typically < 10%)

➤ "Known" Risk (planned)
  - risk has been identified at the start of a program
  - negative outcome may occur in the future, risk mitigation plan exists, active mitigation is started at program start, cost and schedule have been planned for

➤ "Execution" Risk
  - risk has not been identified at the start of a program
  - often the result of actions outside of the program
  - negative outcome may occur in the future
  - risk mitigation plan does not exist, cost and schedule have not been planned for

Risk Management Modeling

- ➢ Extremely simple "Monte Carlo" modeling of risk
- ➢ Simulates 5 years during TD and EMD
- ➢ Options:
  - • cost increase for every task
  - • cost variation for every task
  - • setting a limit on cost uncertainty (i.e., no tasks less than budget)
  - • probability of tasks that have risk
  - • likelihood & consequence
  - • cost to mitigate a risk
  - • effectiveness of mitigation efforts
- ➢ For simplicity, the total budget is set to 1 and the total plan is 60 months.

"I have yet to see any problem, however complicated, which, when you looked at it in the right way, did not become still more complicated."
- Poul Anderson

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➢ Assume: Normal distribution of costs (average=1)
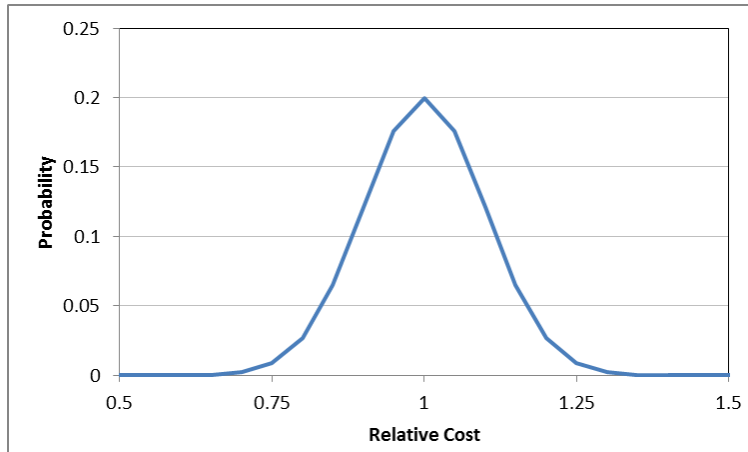
➢ **Win some – lose some**

➢ **On average …**

➢ **Historical data**

➢ **Similar tasks**

➢ Or, assume no cost under-runs
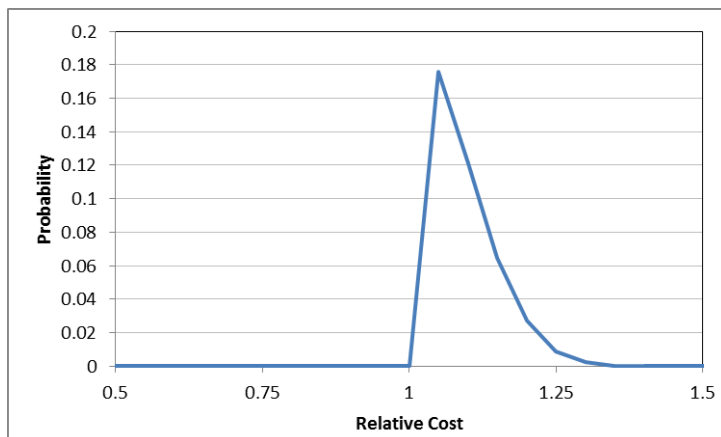
Conditions that might prevent a cost under-run :

➢ **timing of work**

➢ **different teams, divisions, organizations, companies, …**

➢ **contract terms / subcontracting**

➢ **different management objectives**

➢ **different reward systems**

➢ **poor understanding of actual status**

➢ **deferred tasks**

➢ **"there's always more that can be done"**

➢ **sub-optimization**

Actual Cost With Normal Uncertainty
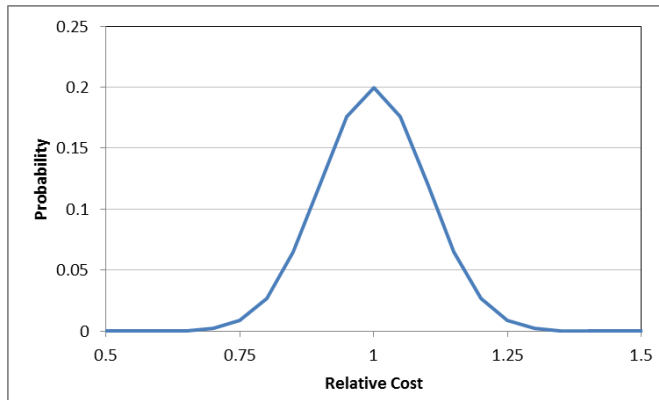
> ➤ **Normal distribution of actual costs around budgeted cost.**

> ➤ **Average cost is on budget**

Planned

SRR
A   SFR   PDR   B   CDR   TRR   C

A   SFR   PDR   B   CDR   TRR   C
    SRR

Actual

MS C is ontime

Average Cost = 1.00

init_budget=1
nyears=5
ntasks=10 per week
cost_fraction=1
cost_sigma=0.1

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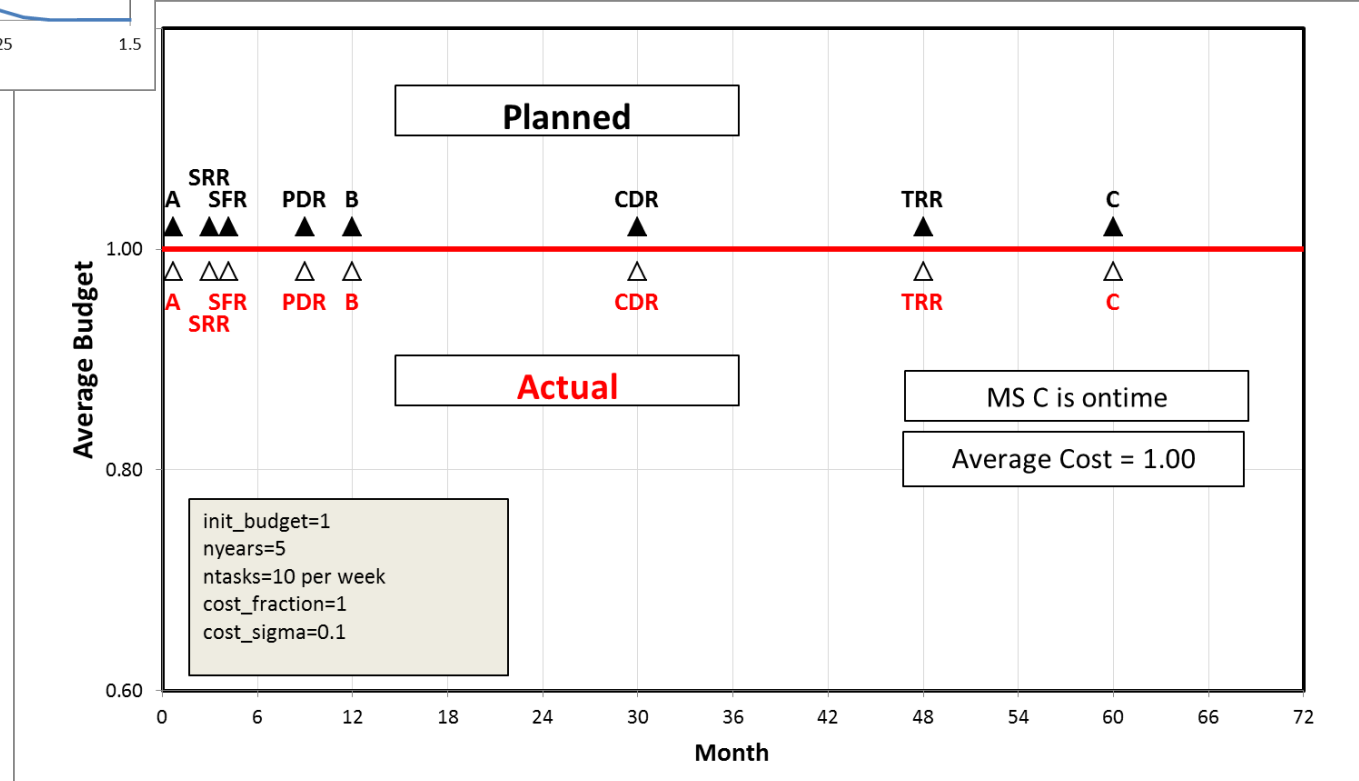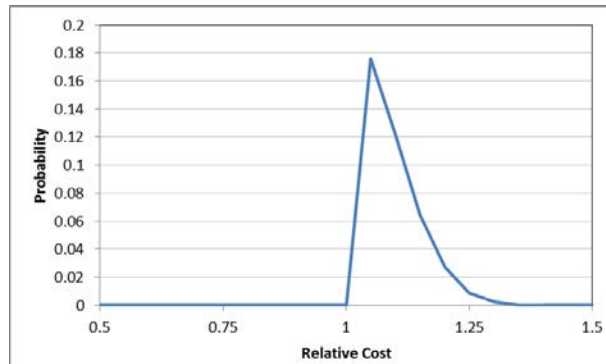
- **Exactly** the same conditions as before except that there are no cost under-runs
- **5.6% cost over-run**

Planned

| | SRR | | | | | | |
| A | SFR | PDR | B | CDR | TRR | C |

Actual

A SRR SFR PDR B CDR TRR C

MS C is 3.5 months late

Average Cost = 1.056

init_budget=1
nyears=5
ntasks=10 per week
cost_fraction=1
cost_sigma=0.1

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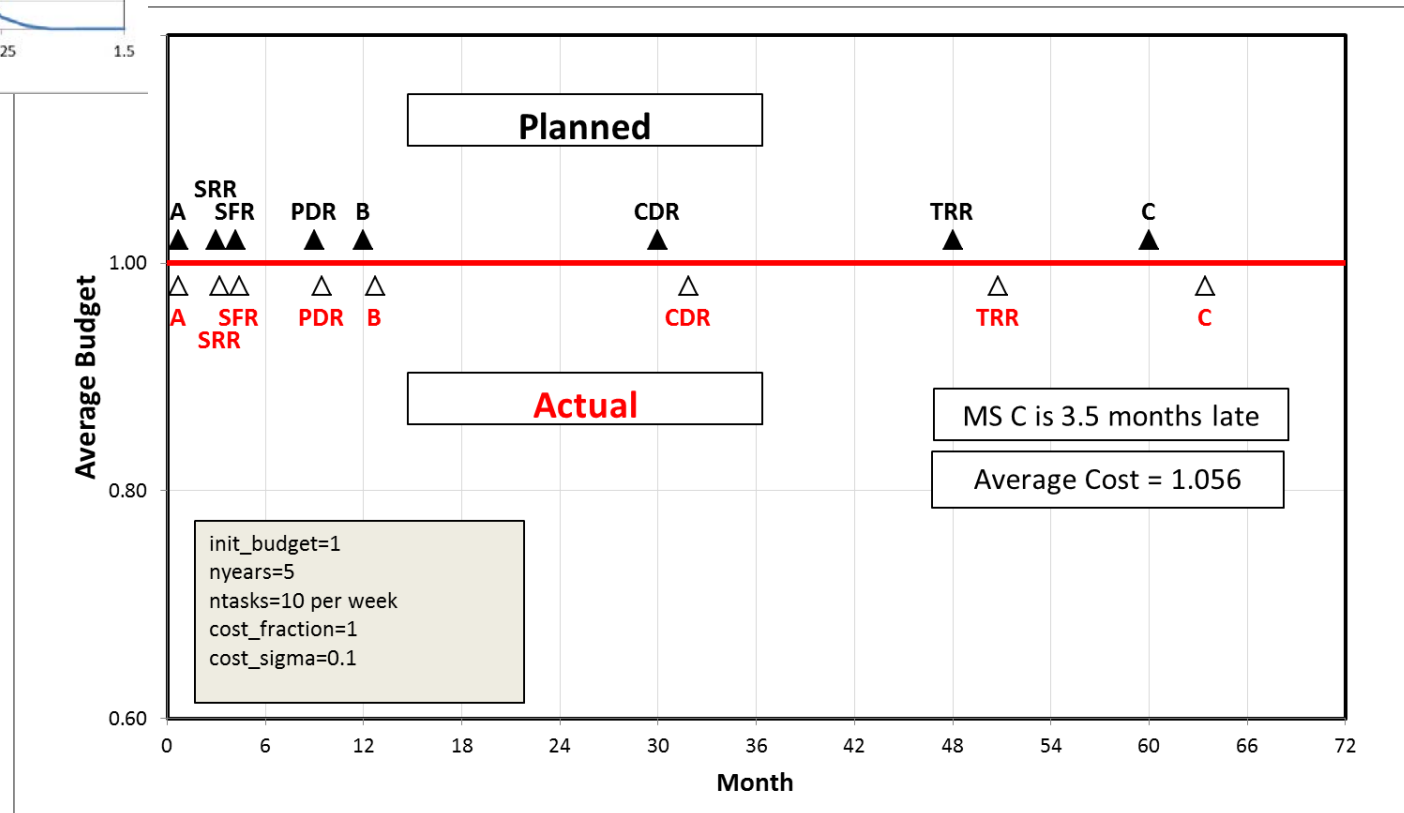
Conclusion #1

➢ When there is uncertainty in the effort to complete tasks, in practice there will be a cost over-runs.

➢ All DoD programs have ambitious goals and there is always uncertainty in program plans.

➢ Therefore, ALL DoD programs will have a cost over-run, a schedule slip and a likely reduction in "performance"*

➢ A cost over-run and schedule slip to some degree is "natural".

"If there is a 50-50 chance that something can go wrong, then 9 times out of ten it will."   - Paul Harvey

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- The risk <u>has not been identified</u> at the start of a program
- High risk assumed: 10% of tasks have risk, likelihood = 50%, cost consequence is 50% of task cost
- Without mitigation, average cost increase is 2.5%.

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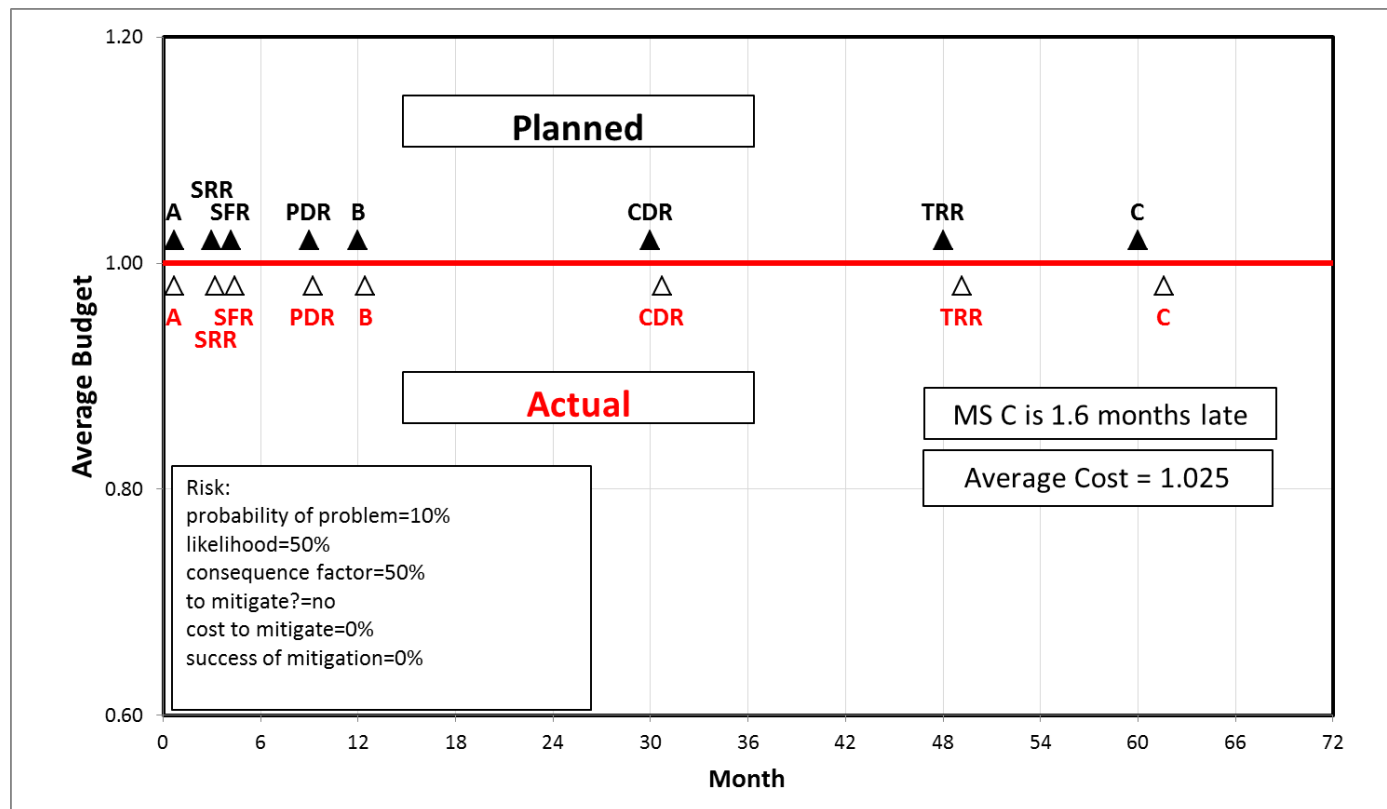
Should You Mitigate?

➢ If you mitigate all risks at the level of the expected loss (= Likelihood * $Consequence)…

    a. If all mitigation efforts are successful. Same answer: 2.5% increase.

    b. But if mitigation efforts are only 50% successful, the cost increase is 3.8%

➢ Break-even point : $C_{\%Mit} = P_{SUCCESS}$

➢ Take-Away: If you aren't successful at risk mitigation, don't do it.

➢ Also, for optimal risk reduction, you need to know how successful you are at risk mitigation (i.e., you need data).

$C_{\%Mit}$ is the fraction of the expected loss that is spent on risk mitigation.

$P_{SUCCESS}$ is the probability of successfully mitigating risks.

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Conclusion #2

➢ Execution Risk ≡ The risk <u>has not been identified</u> at the start of a program

➢ All execution risks will lead to a cost increase and schedule delay, either due to mitigation efforts and/or consequences.

➢ The optimal risk mitigation strategy requires knowledge of the mitigation success rate.

➢ You can't "manage the risk" for free.

> • Performance might be reduced capabilities or fewer assets.
> • "All" really means "on average"

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Topics

1. **Facts concerning major weapon programs**
   - technology maturity (TRL), design maturity, software maturity, earned value management (EVM)
2. Survey of the DoD Workforce on risk management
   - feedback on how RM is used on programs
   - recommendations from survey participants
3. Risk behavior of the DoD workforce
   - propensity to take on risk
4. Simple Monte Carlo modeling of risk
   - Impact on program cost and schedule
5. Best practices, lessons learned and new approaches to risk management from DoD and Industry Program Managers

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Risk Management – Company X

- ➢ Highly profitable company outside of the defense industry.
- ➢ Consumer and business customers.
- ➢ An integrator of hardware, software/firmware, and IT.
- ➢ Size: 100 engineers / 7 platforms
- ➢ Close working relationship with ODM's (Original Design Manufacturers; 1 is critically important to business success)
- ➢ They do not spend a lot of time on <u>formalized</u> risk management and reviews.
- ➢ May brief 5-10 high risks at "phase" reviews. Have trigger points.
- ➢ Brainstorm. Balance. Highly empowered teams.
- ➢ Know from experience. Informal: everyone does it but they might not be consciously doing "risk management"
- ➢ Management by walking around.
- ➢ Business trade-off. Some flexibility in spending.

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- Commercial IT Business Solutions
- Business IT solutions
- Risk to CFO – company may fail
- Cannot put dollar or time value of risk
- (1) Business (2) People (3) Technology and (4) Process
- Client maturity
- Industry standard 10%
- Seller understands the fine print. Buyer doesn't know the fine print.
  - Works both ways for Gov't and contractor. RFP vs. proposal.
- More than 1 year, error in time and cost is 100%.
- A 1-day delay can turn into a 2-week slip
  - e.g., a delayed meeting might delay an important decision until the "decider" is available

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Program Manager Z

- ➢ Manages via Risk Management.
- ➢ Effective RM avoids future problems so that time can be spent on program issues rather than fighting fires.
- ➢ Used DoD Risk Management Guidebook as the basis for RM, but tailored it for their needs.
- ➢ Two benefits for the Branch Manager are getting visibility into the program and forcing PM's to look at risk.
- ➢ Tried to add "urgency" as third element but too complex.
- ➢ "Believes" in payoff.
- ➢ Trying to measure the value of RM.
- ➢ During technology development:
  - • No baseline.
  - • All high risk.
  - • Little consequence of failure: "go as far as you can"

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Conclusions / Summary

➢ Uncertainty first, risk second.

➢ Based on GAO reports
- TRL's, Design Drawings and EVM aren't reducing risk
- Software development and integration are being ignored

➢ The DoD Workforce are big risk takers even when they shouldn't be.

➢ Workforce needs risk management training that focuses on doing it effectively (proficiency training).

➢ If you're not successful at mitigating risks, don't do it.

➢ Cost increases, schedule delays (and often performance shortfalls) are normal outcomes of uncertainty and "execution risks".

➢ Reduce cost over-runs by reducing uncertainty in plans.

➢ More deliverables between CDR and IOT&E.

> "The secret of getting ahead is getting started. The secret of getting started is breaking your complex overwhelming tasks into small manageable tasks, and then starting on the first one."
> - Mark Twain

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